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Analysis of Consumer Attitudes Toward Organic Produce and Purchase Likelihood*

by

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Abstract

This study demographically determines: which consumers are currently buying organic produce; consumer comparisons of organic and conventional produce; and consumer purchase likelihood of higher-priced organic produce. Data were collected from a Delaware consumer survey,

*Published as Miscellaneous Paper No. 1377 of the Delaware Agricultural Experiment Station. The research was funded in part through a grant from the Delaware State Department of Agriculture and Regional Research Project S-222.

dealing with fresh produce and food safety. Multinomial and ordered logit models were developed to generate marginal effects of age, gender, education, and income. Increasing age, males, and advancing education demonstrated positive effects on the likelihood that the consumer was not a regular purchaser of organic produce. Respondents with at least a Bachelor degree were more likely to have organic purchase experience among the non-regular purchasers. A majority of respondents rated organics to be superior overall to conventionally grown produce, with increasing age, males, advancing education, and high income having a negative effect on this probability. Most consumers felt that organic produce would cost at least somewhat more than conventional produce, where females and advancing education positively affected this outcome. Less than one out of every four respondents demonstrated a strong purchase likelihood of a higher-priced organic produce alternative. Young females with a high school degree or less and above average household income were the highest probability group to purchase costlier organic produce.

A nationwide poll concluded that only 28.3 percent of consumers actually sought out organic or limited pesticide-use produce, even though over seventy percent responded that organic produce provides better long-term health effects than conventionally grown produce (Organic Gardening). Some retailers maintain that appearance and price are prohibitive factors in consumer adoption of organic produce (Mejia). These indicators suggest that consumer apathy towards healthfulness hinders consumers from searching out organic produce. However, an area study has shown that availability was consistently identified as a major explanation for not purchasing organics (Byrne). Perhaps consumers are not even aware that the organic alternative exists, or they are not willing to look for organics outside of supermarkets or roadside stands (Byrne).

Ireland and Falk stated that "a majority of groceries do not handle organics because of low availability and perceived consumer demand." Their study found that food retailers, who do handle organics, were almost unanimous in stating that availability was not a problem. Ott and Maligaya found that the majority of consumers would reject organics, if organics were of a lesser quality than conventionally grown produce.

Since organics have grown to be a billion dollar industry (Waterfield), one may assume genuine consumer demand. The studies discussed here do show a purchase likelihood restraint due to price and quality. The Delmarva study indicates that availability is also a deterrent, perhaps larger than price and quality (Byrne).

The purpose of this study is to determine which consumers are and are not buying organic produce, and to analyze their characteristic relationships between organic and conventionally grown produce, as well as their purchase likelihoods. Additionally, the study analyzes the effects that consumer demographics have on these relationships.

Data

The data were collected from a consumer study on opinions about fresh produce, conducted in 1990 for the state of Delaware. A random mailing sample of 6,100 telephone subscribers, based on zip code population and including unlisted households, was obtained from Donnelly Marketing (Nevada, Iowa). There were 753 usable questionnaires returned for a response rate of 12.34 percent not including refused, unusable, and deceased returns. Since average household size for the survey was 2.74, the response rate represents 0.30 percent of the total Delaware population. Based on the sample size relative to the total population and the use of random sampling procedures, there is a 95 percent confidence in the accuracy of the results within three percentage points (Dillman). More importantly, the various demographic and social subgroups of respondents were well represented, and are summarized in Table 1.

Procedures

Multinomial Logit Models

Two survey questions dealt with organic produce purchase experience, having possible responses of yes, no, or do not know. Since there is no apparent ordering of these alternatives,

Table 1: Demographic Characteristics of Respondents, Delaware 1990.

CHARACTERISTIC	N	PERCENT
AGE		
18-34 YEARS OF AGE	174	23.6
35-49	263	35.7
50-64	175	23.7
65 OR OLDER	125	17.0
TOTAL	737	100.0
SEX		
MALE	363	49.3
FEMALE	374	50.7
TOTAL	737	100.0
EDUCATION		
LESS THAN HIGH SCHOOL	39	5.3
HIGH SCHOOL GRADUATE	208	28.2
SOME COLLEGE	151	20.5
BACHELOR DEGREE	183	24.8
SOME GRADUATE WORK OR DEGREE	156	21.2
TOTAL	737	100.0
ANNUAL HOUSEHOLD INCOME		
<$10,000	12	1.7
$10,000-19,999	49	7.0
$20,000-29,999	91	13.0
$30,000-39,999	100	14.3
$40,000-49,999	142	20.3
$50,000-59,999	89	12.7
$60,000-69,999	59	8.4
$70,000 OR HIGHER	158	22.6
TOTAL	700	100.0

SOURCE: DELAWARE CONSUMER SURVEY AND CALCULATIONS

multinomial logit modelling is the methodology of choice. Estimation techniques for overall probabilities and marginal probability effects are explained in Appendix A. All probabilities are calculated at the means and marginal effects were estimated ceteris paribus. The regression model is:

$$Y = \beta_0 + \beta_1 AGE + \beta_2 MALE + \beta_3 SOME\ COLLEGE + \beta_4 BACHELOR\ DEGREE + \beta_5 POST\text{-}GRADUATE + \beta_6 HIGH\ INCOME \quad (1)$$

where Y = 0, 1, or 2 for do not know, no, or yes responses respectively.

AGE = respondent age in years.

MALE = 1 if male; 0 otherwise.

SOME COLLEGE = 1 if only attended some college; 0 otherwise.

BACHELOR DEGREE = 1 if completed Bachelor degree; 0 otherwise.

POST-GRADUATE = 1 if completed some graduate work; 0 otherwise.

HIGH INCOME = 1 if annual household income > $40,000; 0 otherwise.

The base group consisted of females with a high school degree or less and an annual household income of less than $40,000. The do not know, no, and yes observed frequencies for whether they regularly buy organic produce were .2027, .6790, and .1183 respectively. Similarly, the observed frequencies for whether non-regular purchasers have ever bought organics were .3139, .2281, and .4580 respectively.

Ordered Logit Models

The other questions representing dependent variables were contingent valuation measures, based on a scale of one to seven. For estimation purposes, the dependent variables were aggregated into three categories.

Responses to one question reflect consumers' overall ratings of organic produce compared to conventionally grown produce where:

RATE = 0 for organic quality lower than conventional

RATE = 1 for organic quality same as conventional

RATE = 2 for organic quality higher than conventional.

The observed frequency responses for RATE were .0972, .2693, and .6411, respectively.

Another question deals with consumer perceptions of organic costs versus conventional costs where:

COST = 0 when organic cost is same or lower

COST = 1 when organic cost is somewhat higher to higher

COST = 2 when organic cost is much higher.

The observed frequency responses for COST were .2986, .4857, and .2157, respectively.

The final question measures consumer likelihood to purchase organic produce, even if it costs more, where:

PURC = 0 for unlikely
PURC = 1 for neutral to somewhat unlikely
PURC = 2 for likely to very likely.

The observed frequency responses for PURC were .3848, .3863, and .2319 respectively. Observed frequency responses represent respondents that gave complete information on both the dependent and independent variables.

The ordered logit models are identical to equation (1), where Y now represents RATE, COST, or PURC. The objective of these multinomial and ordered logit models is to analyze the demographic effects on the relevant dependent variable, not to predict outcomes for individuals.

Prediction of this nature would not be a practical application, since too much emphasis must not be placed on prediction ability or the original intent of the model is often diminished in efforts to improve prediction (Greene). Instead, good parameter estimates of the true independent variables are needed for characterization of the population. Maximum likelihood estimators, which are used for logit modelling, are chosen to maximize the combined density of the observed dependent variable, as opposed to classical regression where estimates are chosen to maximize the fitting of the dependent variable prediction and thus maximizing R^2. In addition, a good fitting of the observed dependent variable and achieving valid coefficient estimates is not necessarily compatible (Greene). Hence, inclusion of pseudo-independent variables, such as safety rating, were not used so as to avoid artificial inflation of prediction and reduction of true independent variable effects.

Model significance for these structural analysis models were verified through the chi-square value, resulting as a difference of the restricted and unrestricted log likelihood functions. The restricted regression for these models is defined as the intercept being the only right hand side variable (Maddala). Significance was further checked through comparison of the observed frequencies and the estimated overall probabilities. Parallelism for the ordered logit models was confirmed by the Score Test for the Proportional Odds Assumption (SAS).

Empirical Results

Regular Organic Purchases Model

The overall probabilities for whether consumers do not know if they are, are not, or are regular purchasers of organic produce were .1901, .6989, and .1110, which closely resemble the observed frequencies and a significant chi-square measure of model significance (Table 2).

Age was highly significant for the no response, where a respondent 10 years older than the mean would be 14.5 percent more likely to not be a regular buyer of organic produce. However, the marginal effects for AGE indicate that AGE mainly affects the choice between do not know and no, meaning age does not play a significant role in the makeup of regular organic consumers.

MALE was significant for the yes response, indicating males have a 5.35 percent lower probability of being a regular organic consumer. Gender was not significant in determining consumers that do not know if they regularly purchase organics.

Probability of a respondent not being a regular organic consumer increases with advancing education, where a respondent with a Bachelor degree was 18.59 percent and a post-graduate was 28.60 percent more likely to respond negatively than person with a high school degree or less. The probability of a do not know response predictably decreases with advancing education. While the effects were not as large as for the other two responses, tendency to be a regular organic buyer decreases with advancing education.

Income was not a significant variable in the model. The model suggests that young females with a high school education or less have the highest probability of being a regular buyer of organic produce.

Organic Purchase Experience

Probabilities of organic purchase experience, for consumers that do not regularly buy organics, closely resemble the observed frequencies (Table 3).

AGE was not significant but does suggest that older individuals are more likely to have purchased organics. Also, younger individuals seem more likely not to know if they have bought organic produce. Though not significant, females are more likely to have never bought organics, and males are slightly more likely to not know if they have bought organics. Previous organic purchase probabilities increase with advancing education, which decreases the probability that they do not know if they have purchased organics. BACHELOR DEGREE individuals are 12.55 percent and POST-GRADUATE individuals are 22.94 percent less likely to indicate that they do not know than those consumers with a high school degree or less. Income was not significant but

TABLE 4: ORDERED LOGIT PROBABILITIES AND DEMOGRAPHIC EFFECTS FOR OVERALL RATINGS OF ORGANIC PRODUCE VERSUS CONVENTIONALLY GROWN PRODUCE, DELAWARE 1990.

	P_0[1] LOWER	P_1[2] SAME	P_2[3] HIGHER
Overall (Chi-squared = 48.883[a])	.0836	.2697	.6330
Marginal Effects			
Age[a] (Mean = 46.813)	.0015[4]	.0041	-.0056
Male[a]	.0483[5]	.0944	-.1427
Some College	.0225[5]	.0492	-.0717
Bachelor Degree	.0233[5]	.0508	-.0741
Post-Graduate[a]	.0546[5]	.1020	-.1566
High Income[c]	.0287[5]	.0590	-.0877

N = 545

[a] - significant at the .01 level
[b] - significant at the .05 level
[c] - significant at the .10 level
[1] - computed as $P_0 = e^{-\beta'x}/1+e^{-\beta'x}$
[2] - computed as $P_1 = e^{M\mu-\beta'x}/1+e^{M\mu-\beta'x} - P_0$
[3] - computed as $P_2 = 1 - (P_0 + P_1)$
[4] - marginal effect(ME) of continuous variable Age calculated:
P_0: $-[P_0 * (1 - P_0)] * \beta_{age}$
P_2: $[P_2 * (1 - P_2)] * \beta_{age}$
P_1: $0 - (P_0 + P_2)$
[5] - ME of dummy variables calculated:
$ME = P_i[y=1] - P_i[y=0]$
Source: Delaware Consumer Survey and Calculations.

TABLE 3: MULTINOMIAL LOGIT OVERALL PROBABILITIES AND DEMOGRAPHIC EFFECTS (prob value for coefficient estimates) FOR ORGANIC PURCHASE EXPERIENCE OF CONSUMERS WHO DO NOT REGULARLY BUY ORGANICS, DELAWARE 1990.

	P_0[1] DO NOT KNOW	P_1[2] NO	P_2[3] YES
Overall (Chi-squared = 30.88[a])	.3094	.2317	.4589
Marginal Effects			
AGE (Mean = 47.014)	-.0034[4]	.0002 (.5641)	.0032 (.2129)
MALE	.0398[5]	-.0178 (.3857)	-.0220 (.3820)
SOME COLLEGE	-.0068[5]	-.0934 (.1849)	.1002 (.3147)
BACHELOR DEGREE	-.1072[5]	-.0183 (.4225)	.1255[b] (.0179)
POST-GRADUATE	-.2255[5]	.0039[b] (.0176)	.2294[a] (.0000)
HIGH INCOME	.0210[5]	-.0428 (.3046)	.0218 (.9224)

N = 583

[a] - significant at the .01 level
[b] - significant at the .05 level
[1] - computed as $P_0 = 1 / 1 + \Sigma^2_{k=0} e^{\beta' jxi}$
[2] - computed as $P_{1 \text{ or } 2} = e^{\beta' jxi} / 1 + \Sigma^2_{k=0} e^{\beta' jxi}$
[3] - marginal effect(ME) of continuous variable Age calculated:
$\partial P_j / \partial AGE = P_j [\beta_j - (\Sigma_{AGE} P_{AGE} \beta_{AGE})]$
[4] - ME of dummy variables calculated:
$ME = P_i[y=1] - P_i[y=0]$

Source: Delaware Consumer Survey and Calculations

results show that higher income households are less likely to not have purchased organic produce. Demographically, the model demonstrates that respondents with at least some post-graduate work are the highest probability group to have purchased organic produce, among those consumers that do not regularly purchase organics. Overall, 31.39 percent of those surveyed stated that they do not know if they have ever bought organic produce.

Organic Versus Conventional Model

The model's overall probabilities for consumer ratings of organic produce compared to conventional were .0836 for organics being rated lower than conventional, .2693 for same, and .6471 for organics being rated higher than conventionally grown produce (Table 4). The overall probabilities favorably compare to the observed frequencies and the chi-square value was highly significant.

Advancing age results in a lower likelihood to rate organics higher overall than conventional produce. A respondent ten years older than the mean would be 5.6 percent less likely to rate organics higher than the average AGE individual. Gender was also significant, where males would be 14.27 percent less likely to rate organics higher than conventional produce, compared to females. Education was only significant for the POST-GRADUATE variable, but the education variables do present a consistent trend. As education advances through post-graduate, the likelihood to rate organics higher has a negative relationship. Consumers with at least some post-graduate work were 15.66 percent less likely to rate organics higher than the base group of high school diploma or less. HIGH INCOME households were 8.77 percent less likely to rate organics higher, compared to lower income households. The highest probability profile for rating organics higher would be a young female with a high school diploma or less and a lower household income. Still, the overall probabilities did exhibit a high likelihood to feel organic produce was superior overall to conventional produce.

Organic Costs Versus Conventional Costs Model

Overall probabilities for comparing organic costs to conventional costs were .2957 for organic costs being the same or lower, .4968 for costs being somewhat higher to higher, and .2075 for organic costs being much higher (Table 5). These probabilities were similar to the observed frequencies and the model has a significant chi-square value.

Age was not significant for cost comparisons between organically and conventionally grown produce. Males were 7.28 percent more likely to rate organic costs lower or the same, compared to females. Advancing education results in a lower likelihood to feel organics would cost the same or less than conventionally grown produce. A POST-GRADUATE respondent would be 12.17 percent less likely to rate organic costs as lower or the same, compared to individuals with a high school degree at most. HIGH INCOME respondents were 8.34 percent less likely to rate organic costs to be the same or lower than would the lower income households. Young males with a high school degree or less and a lower income were the highest probability group to feel that organic produce would cost only as much or less than conventional produce.

Organic Purchase Likelihood Model

Overall probabilities for purchase likelihood of higher-priced organic produce were .3818, .3863, and .2319 representing consumers that are unlikely, neutral to somewhat likely, and likely to very likely respectively, with a significant chi-square value of 14.778 (Table 6).

Though not significant, advancing age exhibits a decrease in probability that the consumer would be at least likely to purchase organic produce. The male probability for being likely to very likely to purchase costlier organics was 5.60 percent lower than that of females. Higher levels of education adversely affect the purchase likelihood. BACHELOR DEGREE has a marginal effect of -.0692 on the likely to very likely option, while POST-GRADUATE had a -.0737 probability. Ability-to-pay was demonstrated in the income variable, with households with an annual

TABLE 4: ORDERED LOGIT PROBABILITIES AND DEMOGRAPHIC EFFECTS FOR OVERALL RATINGS OF ORGANIC PRODUCE VERSUS CONVENTIONALLY GROWN PRODUCE, DELAWARE 1990.

	P_0[1] LOWER	P_1[2] SAME	P_2[3] HIGHER
Overall (Chi-squared = 48.883[a])	.0836	.2697	.6330
Marginal Effects			
Age[a] (Mean = 46.813)	.0015[4]	.0041	-.0056
Male[a]	.0483[5]	.0944	-.1427
Some College	.0225[5]	.0492	-.0717
Bachelor Degree	.0233[5]	.0508	-.0741
Post-Graduate[a]	.0546[5]	.1020	-.1566
High Income[c]	.0287[5]	.0590	-.0877

N = 545

[a] - significant at the .01 level
[b] - significant at the .05 level
[c] - significant at the .10 level
[1] - computed as $P_0 = e^{-\beta'x}/1+e^{-\beta'x}$
[2] - computed as $P_1 = e^{M\mu-\beta'x}/1+e^{M\mu-\beta'x} - P_0$
[3] - computed as $P_2 = 1 - (P_0 + P_1)$
[4] - marginal effect(ME) of continuous variable Age calculated:
P_0: $-[P_0 * (1 - P_0)] * \beta_{age}$
P_2: $[P_2 * (1 - P_2)] * \beta_{age}$
P_1: $0 - (P_0 + P_2)$
[5] - ME of dummy variables calculated:
$ME = P_i[y=1] - P_i[y=0]$

Source: Delaware Consumer Survey and Calculations.

TABLE 5: ORDERED LOGIT OVERALL PROBABILITIES AND DEMOGRAPHIC EFFECTS FOR ORGANIC COST COMPARISON, DELAWARE 1990.

	P_0[1] SAME TO LOWER	P_1[2] SOMEWHAT HIGHER TO HIGHER	P_2[3] MUCH HIGHER
Overall (Chi-squared = 24.189[a])	.2957	.4968	.2075
Marginal Effects			
Age (Mean = 46.584)	-.0008[4]	.0002	.0006
Male[b]	.0728[5]	-.0153	-.0575
Some College	-.0220[5]	.0079	.0141
Bachelor Degree[b]	-.0911[5]	.0220	.0691
Post-Graduate[a]	-.1217[5]	.0215	.1002
High Income[b]	-.0834[5]	.0212	.0622

N = 663

[a] - significant at the .01 level
[b] - significant at the .05 level
[c] - significant at the .10 level
[1] - computed as $P_0 = e^{-\beta'x}/1+e^{-\beta'x}$ (Greene)
[2] - computed as $P_1 = e^{M\mu-\beta'x}/1+e^{M\mu-\beta'x} - P_0$ (Greene)
[3] - computed as $P_2 = 1 - (P_0 + P_1)$ (Greene)
[4] - marginal effect(ME) of continuous variable Age calculated:
P_0: $-[P_0 * (1 - P_0)] * \beta_{age}$
P_2: $[P_2 * (1 - P_2)] * \beta_{age}$
P_1: $0 - (P_0 + P_2)$
[5] - ME of dummy variables calculated:
$ME = P_i[y=1] - P_i[y=0]$
Source: Delaware Consumer Survey and Calculations

TABLE 6: ORDERED LOGIT OVERALL PROBABILITIES AND DEMOGRAPHIC EFFECTS FOR CONSUMER LIKELIHOOD TO PURCHASE ORGANIC PRODUCE EVEN IF IT COST MORE, DELAWARE 1990.

	P_0[1] UNLIKELY	P_1[2] NEUTRAL TO SOMEWHAT LIKELY	P_2[3] LIKELY TO VERY LIKELY
Overall (Chi-squared = 14.778[a])	.3818	.3863	.2319
Marginal Effects			
Age (Mean = 46.624)	.0013[4]	-.0003	-.0010
Male[b]	.0741[5]	-.0181	-.0560
Some College	.0055[5]	-.0007	-.0048
Bachelor Degree[b]	.0915[5]	-.0223	-.0692
Post-Graduate[b]	.0985[5]	-.0248	-.0737
High Income	-.0518[5]	.0123	.0395

N = 673

[a] - significant at the .01 level
[b] - significant at the .05 level
[c] - significant at the .10 level
[1] - computed as $P_0 = e^{-\beta'x}/1+e^{-\beta'x}$ (Greene)
[2] - computed as $P_1 = e^{M\mu-\beta'x}/1+e^{M\mu-\beta'x} - P_0$ (Greene)
[3] - computed as $P_2 = 1 - (P_0 + P_1)$ (Greene)
[4] - marginal effect(ME) of continuous variable Age calculated:
P_0: $-[P_0 * (1 - P_0)] * \beta_{age}$
P_2: $[P_2 * (1 - P_2)] * \beta_{age}$
P_1: $0 - (P_0 + P_2)$
[5] - ME of dummy variables calculated:
$ME = P_i[y=1] - P_i[y=0]$
Source: Delaware Consumer Survey and Calculations

income greater than $40,000 have a 3.95 percent higher probability to be likely or very likely to purchase higher-priced organic produce. The highest probability group to purchase costlier organics would be females with a high school degree or less and a higher household income.

Conclusions

The objective of this study was to assess demographic effects on consumer attitudes, perceptions, and purchase experience regarding to organic produce. It was found that females with a high school degree or less are more apt to be regular purchasers of organic produce. Advancing education and age diminishes the probability of a consumer being uncertain of whether their regular produce purchases are organic or not. Higher education levels increase the likelihood that the consumer has purchased organics in the past, but that they are unlikely to do so in the future. A majority of consumers would be likely to rate organic produce superior overall to conventionally grown produce; however, advancing age, higher education levels, higher income households, and males have a negative effect on this likelihood. Increasing age, females, higher education, and higher income have positive effects on consumer likelihood to feel that organic cost would be much higher than conventional produce costs. Consumer awareness of the higher price associated with organic produce is substantiated by the overall probabilities of organic costs being at least somewhat higher. Females without a college degree and higher household incomes are the most likely profile to purchase costlier organically grown produce.

In general, advancing age, higher education, and males demonstrate negative effects on the organic alternative. While higher income households do not necessarily favor organic produce purchases, their ability to pay for the higher priced good is evident from their positive purchase likelihood result.

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Appendix A

Multinomial Logit. In situations when there are more than two alternatives for the dependent variable with no obvious ranking, the multinomial logit procedure is a useful technique. In this study, multinomial logit models are used for do not know, no, or yes alternatives and labelled 0, 1, and 2 respectively. The model is:

$$Prob[Y = j] = \frac{e^{B'jxi}}{\sum_{k=0}^{2} e^{B'jxi}} \qquad \text{(A-1)}$$

where j is an outcome, β_j is the vector of coefficients for the specific outcome, x_i is the matrix of explanatory variables, and k represents all outcomes. The intercept and slope coefficients are unique to each alternative. Indeterminacy for the model is solved by normalizing the yes and no outcomes with the do not know outcome. So, $\beta_j^* = \beta_j + q$ where q represents the do not know vector, which is nonzero. Nerlove and Press provide a convenient solution to the normalization problem by assuming $\beta_0 = 0$. The probabilities for the three outcomes can then be retrieved by:

$$Prob[Y=j] = \frac{e^{B'jxi}}{1+\sum_{k=0}^{2} e^{B'jxi}} \quad for\ j=1,2 \qquad \text{(A-2)}$$

and,

$$Prob[Y=0] = \frac{1}{1+\sum_{k=0}^{2} e^{B'jxi}} \qquad \text{(A-3)}$$

where β'_k now represents the intercepts and slope coefficients of the yes and no outcomes. Note that this solution (A-1) would be identical to a binomial case when J=1. Since these coefficients are normalized, the signs and magnitudes are difficult to interpret in their present form. Like the binomial case, a similar differentiation for marginal effects yields:

$$\frac{\alpha P_j}{\alpha x} = P_j\,[\beta_j - (\Sigma_k P_k \beta_k)] \qquad \text{(A-4)}$$

where β_j and P_j represents the parameter and probability respectively of one of the two normalized outcomes, and β_k and P_k represents the other outcome. Through the imposed assumption of linear homogeneity, the marginal effect on the do not know outcome can be determined. Marginal effects are only useful in analyzing continuous independent variables, such as respondent age in years. Regressors were set to their means in establishing marginal effects. Dummy variable effects were measured as the probability difference between X_i values of zero and one.

Since the regressor vectors included a constant term, the appropriate goodness of fit measure is the log likelihood ratio. Multinomial logit models have the tendency to predict the same response for all observations in an unbalanced sample, which is the norm rather than the exception. Thus, prediction accuracy is not an adequate measure for these models (Greene).

Ordered Logit. The difference between ordered logit and multinomial logit is that the ordered logit responses have an apparent ranking, such as worse, same, and better when comparing two goods. Multinomial logit would fail to compensate for the ordered ranking of the dependent study. For this study, there are three ordered outcomes, labelled zero, one, and two. Econometrically, the major difference between multinomial and ordered logit is that ordered outcomes share the same slope coefficient values, while the intercepts remain different. In estimating a three probability model, only one intercept change is necessary for probability determination. By rearranging the traditional binomial case to solve for Y=0 outcome, the result is:

$$Prob[Y = 0] = \frac{e^{-\beta' x}}{1 + e^{-\beta' x}} \qquad \text{(A-5)}$$

The parameter μ, which is estimated with β and represents the change in intercept, can be added to $-\beta'x$ and results in the combined probability of a 0 or 1 outcome. Hence:

$$Prob[Y = 1] = \frac{e^{\mu-\beta'x}}{1 + e^{\mu-\beta'x}} - \frac{e^{-\beta'x}}{1 + e^{-\beta'x}} \quad \text{(A-6)}$$
$$= \frac{e^{\mu-\beta'x}}{1 + e^{\mu-\beta'x}} - Prob[Y = 0]$$

Thus,

$$Prob[Y = 2] = 1 - \frac{e^{\mu-\beta'x}}{1 + e^{\mu-\beta'x}} \quad \text{(A-7)}$$
$$= 1 - Prob[Y = 0] - Prob[Y = 1]$$

The marginal effects of continuous variables for the ordered logit model are calculated similarly to the binomial model. However, the negative sign in (A-5) must be represented in the marginal effects solution, since the negative sign reflects the leftward or negative movement on the probability curve.

$$\frac{\alpha E[Y=0]}{\alpha x} = -[P_0(1 - P_0)]\,\beta \quad \text{(A-8)}$$

The marginal effect (ME) for the Y=2 outcome is identical to (A-8), excluding the initial negative sign. Solution for the middle outcome is accomplished by:

$$ME\ [Y = 1] = 0 - P_0 - P_2 \quad \text{(A-9)}$$

However, the ME for this middle outcome is ambiguous, since movement is leftward (-) and rightward(+). The signs of the bordering outcomes are unambiguous.

The objective of the ordered logit models in this study was to analyze the structures of the models, i.e., to determine the demographic effects on the probabilities. Therefore, prediction accuracy is not a critical goodness of fit measure. Instead, the chi square values of the log likelihood ratios are the critical measures of explanatory power.